During the early years of LANL operations, land within the Sandia watershed was used to test neutron initiators and other types of implosion tests. Though there have been few official LANL activities in the Sandia watershed since 1948, it has been potentially impacted by outfalls and run-off from mesa-top activities.

4.2.1 Current State

As Figure 4.2a1 shows, there are no existing airborne discharges (Hazard Category A) within the Sandia watershed.

Figure 4.2a2 shows a number of existing surface sources within Sandia watershed, primarily associated with liquid discharges from operating facilities. The existing pathway controls are identified in the accompanying conceptual site exposure model for surface releases under current conditions.

As seen in Figure 4.2a3, there are no subsurface sources of contamination in the Sandia watershed.

4.2.2 Risk-Based End State

The risk-based end-state analogs of the current-state hazard-specific maps for the Sandia watershed are shown in Figures 4.2b1, 4.2b2, and 4.2b3, for anticipated airborne, surface, and subsurface contaminant sources in 2035. Since surface contamination is the only significant hazard in this watershed, the end state reflects cleanup to industrial-use and/or recreational-use levels for lands that will be retained by LANL in 2035. The associated end-state conceptual site exposure model for Hazard Category B in Sandia watershed is attached to Figure 4.2b2.

4.3 Hazard Area 3 – Mortandad Watershed

The Mortandad watershed is an east to southeast trending canyon that heads on the Pajarito Plateau near the main LANL complex at an elevation of 7380 ft asl. The drainage extends about 15 mi from the headwaters to its confluence with the Rio Grande at an elevation of 5440 ft asl, draining an area of about 9 mi^2. The canyon crosses San Ildefonso Pueblo land for several miles before joining the Rio Grande. The canyon passes through or is adjacent to several of LANL's main operational sites.

The watershed canyon is cut into the Tshirege Member of the Bandelier Tuff, with steep walls that are near vertical in some places. The canyon floor is narrow from the head and widens eastward. The stream channel is entrenched in the wider portion of the canyon.

The streamflow in the upper portions of the Mortandad watershed is ephemeral with no known springs. Treated effluent from the Los Alamos County White Rock Sewage Treatment Plant enters they canyon near the LANL boundary and generally flows to the Rio Grande.

Secondary liquid and sludge wastes have been discharged into different sections of the Mortandad watershed from two of LANL's central wastewater treatment plants. One of the plants operated between 1951 and 1963, and the other since 1963. The current discharges are permitted and monitored consistent with the Clean Water Act.

The central reach of the Mortandad watershed is bordered on the south by a mesa where several major core-mission facilities are located. There are many legacy-waste sites associated with former operations at these facilities. The contamination potentially transported from mesas into the watershed is judged to be insignificant relative to the impacts associated with former treated wastewater discharges.

Surface-water flow and alluvial groundwater in the Mortandad watershed is heavily monitored downgradient from the discharge locations. The effluent from the operating liquid-waste treatment facility exceeded the DOE DCGs for radionuclides six times from 1993 to 1995: for americium-241 in 1993; for americium-241 and plutonium-238 in 1994; and for plutonium-238, plutonium-239, 240, and americium-241 in 1995 (Environmental Protection Group 1996). In addition, the effluent has exceeded the New Mexico groundwater standard for nitrate in 1993, 1994, and 1995 (Environmental Protection Group 1996).

An indication of the magnitude of contaminant transport in surface water comes from sampling and analysis in the sediment traps, which are surface berms installed to slow surface water and deposit entrained sediments before crossing the LANL boundary. In the summer of 1991, severe thunderstorms

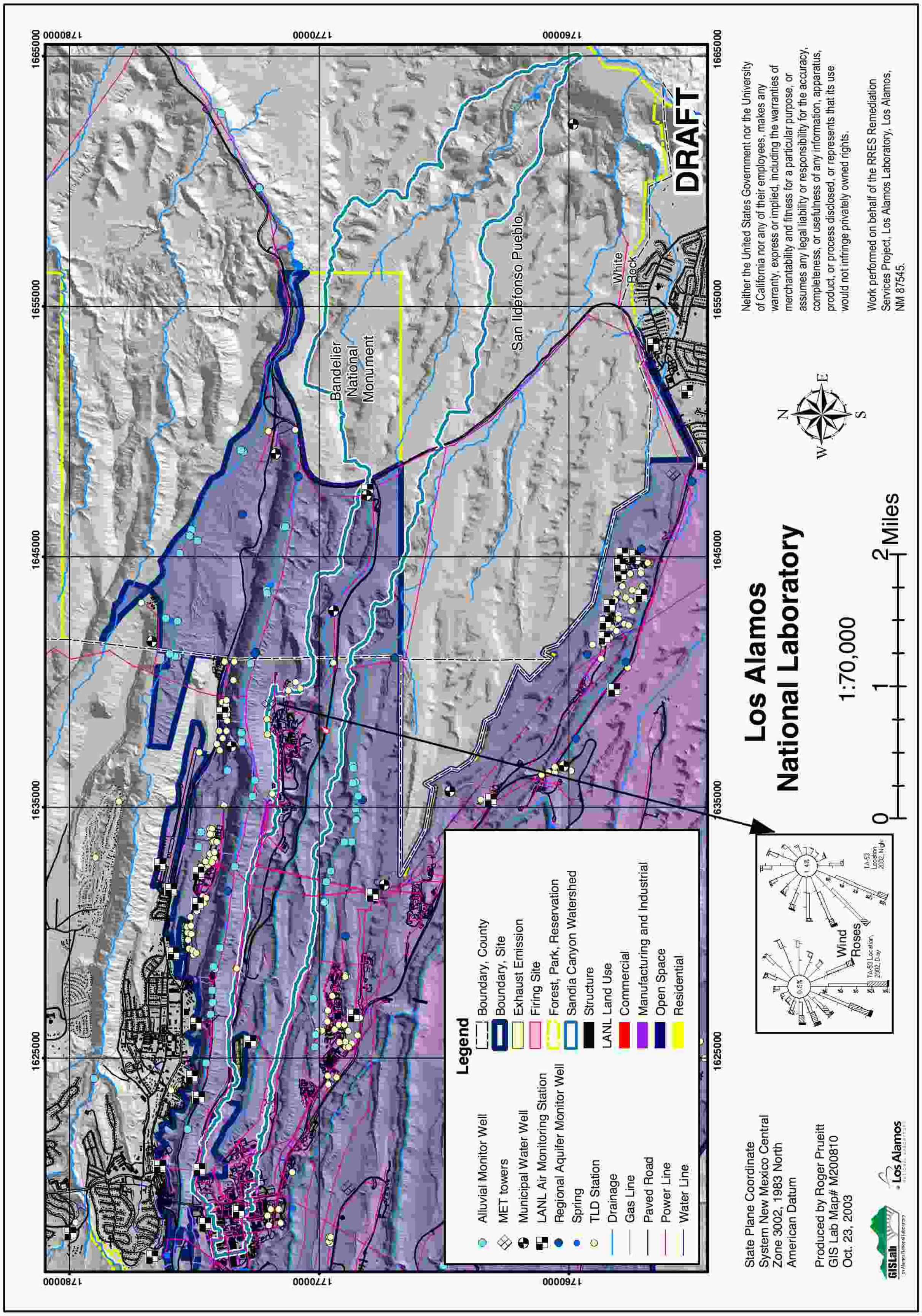

Figure 4.2a1. Hazard Area 2: Sandia Canyon Watershed, Hazard Category A: airborne releases, Current state.

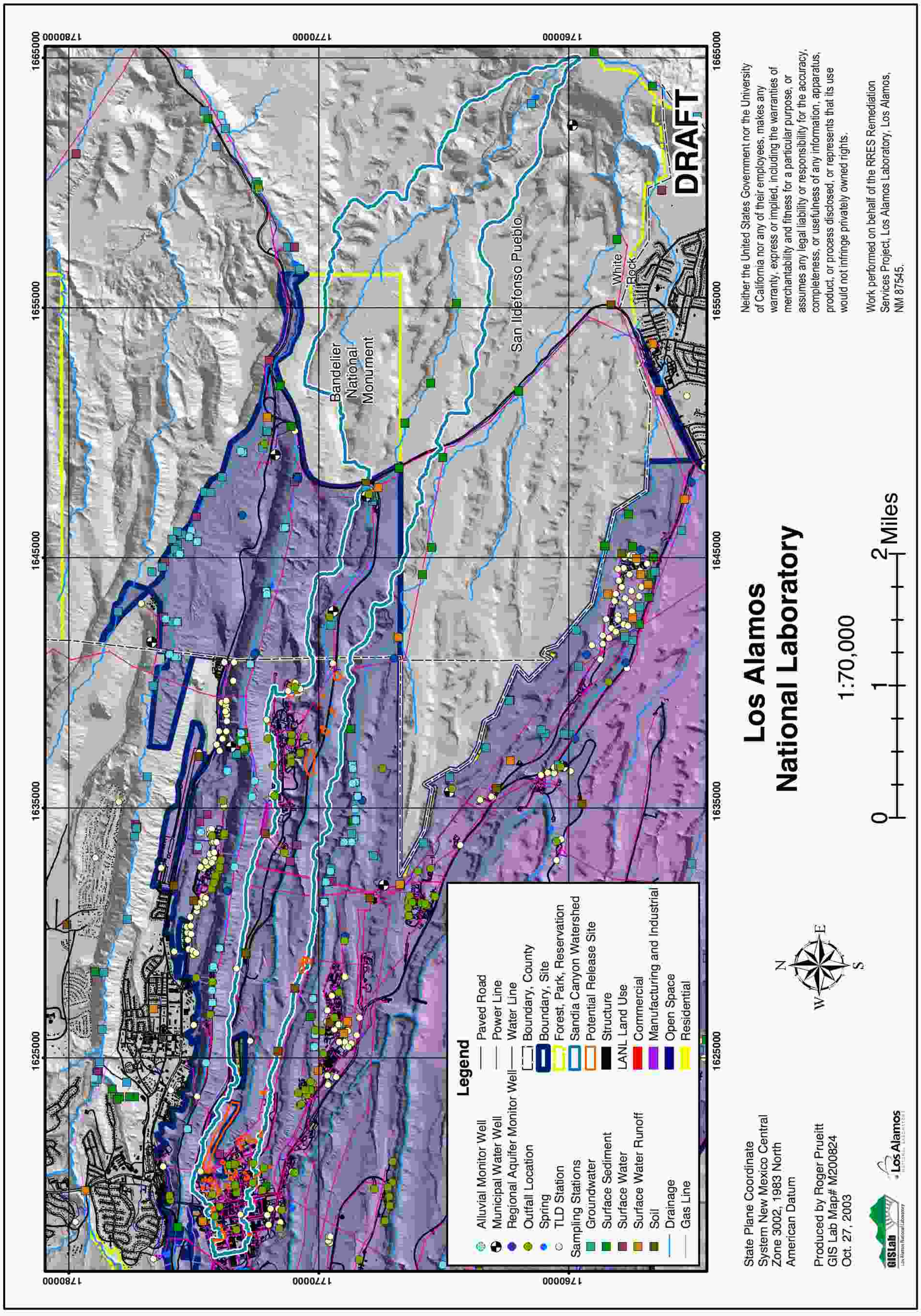

Figure 4.2a2. Hazard Area 2: Sandia Canyon Watershed, Hazard Category B: surface releases, Current state.

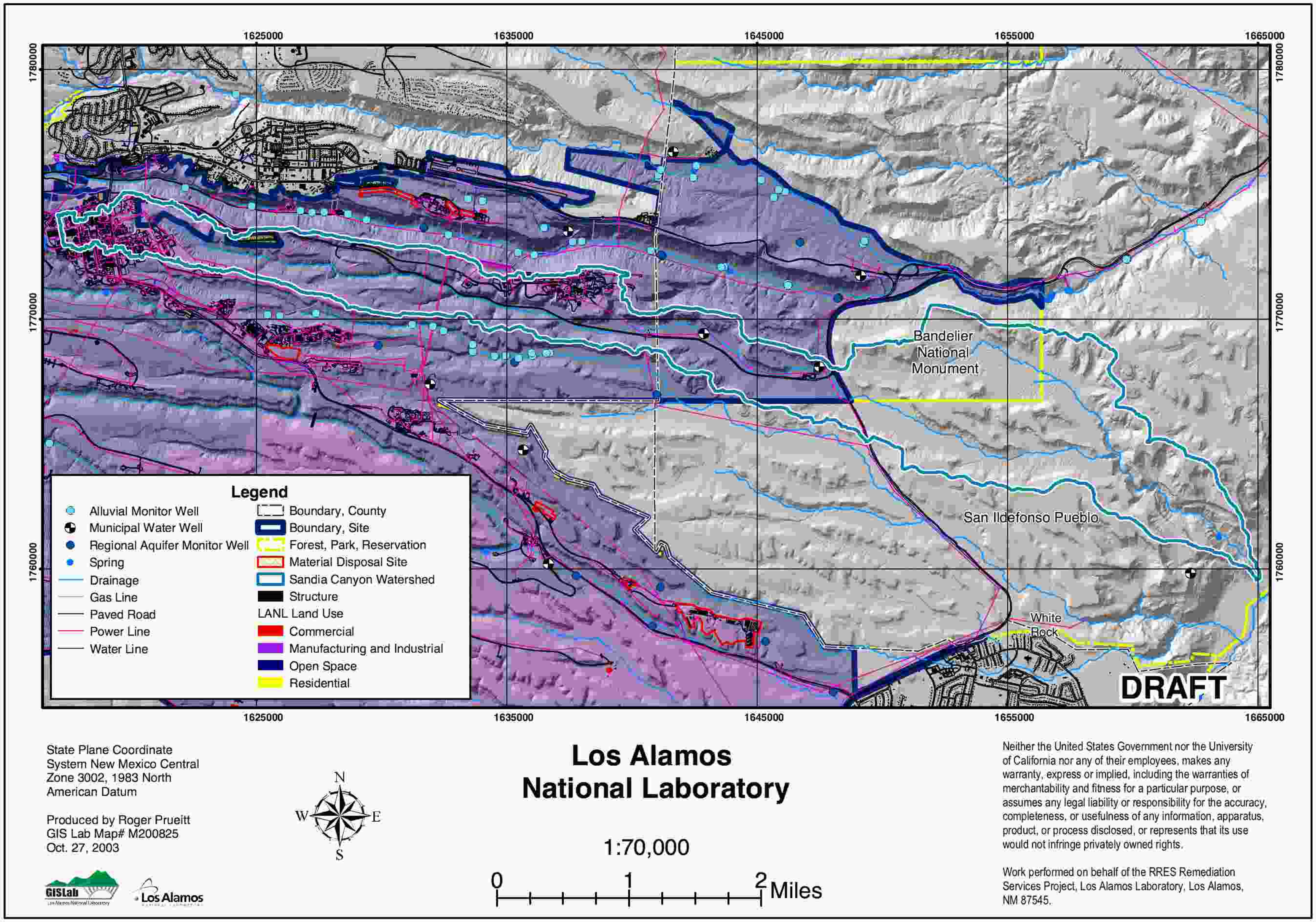

Figure 4.2a3. Hazard Area 2: Sandia Canyon Watershed, Hazard Category C: subsurface releases, Current state.

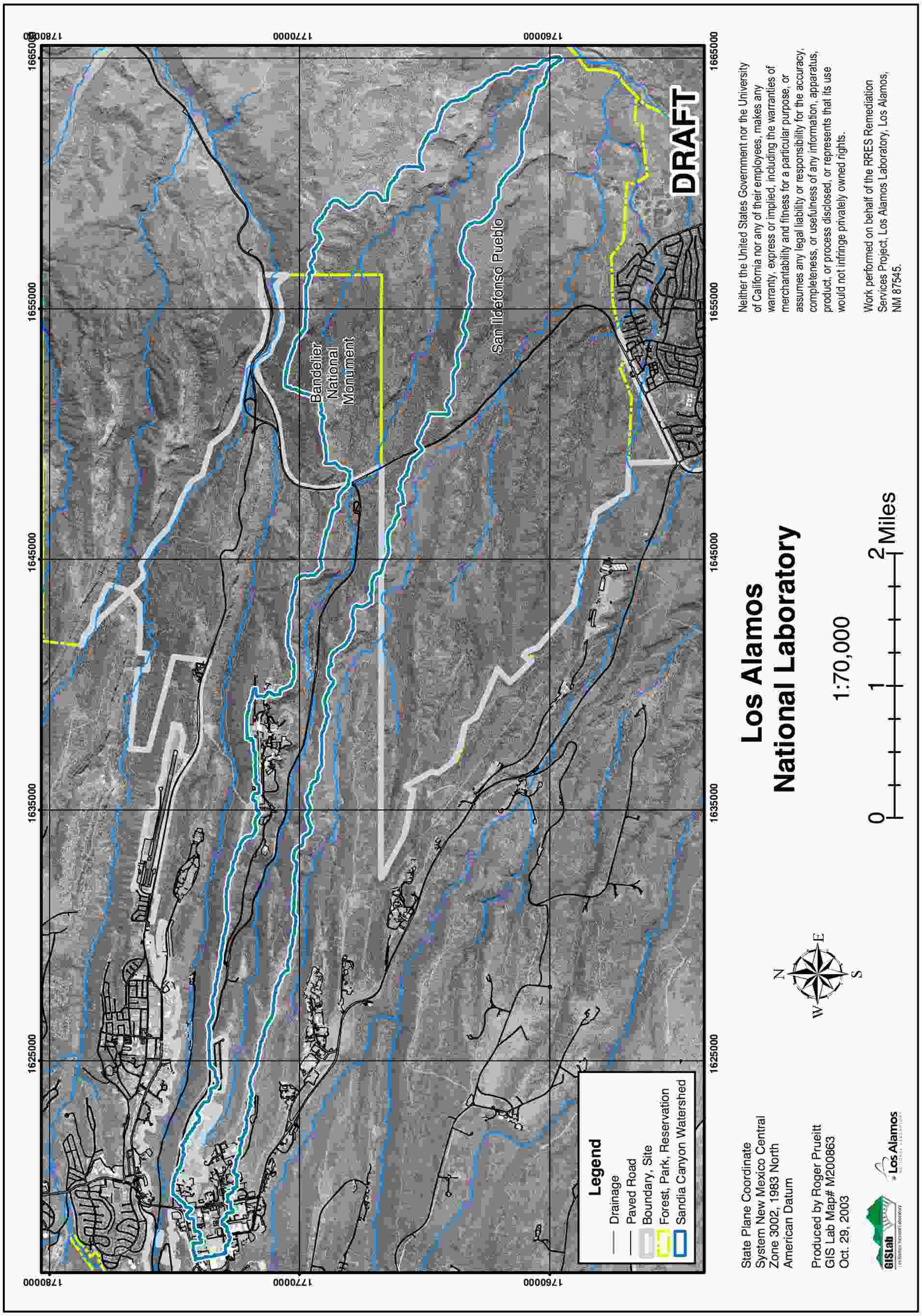

Figure 4.2a4. Hazard Area 2: Sandia Canyon Watershed orthophoto map.

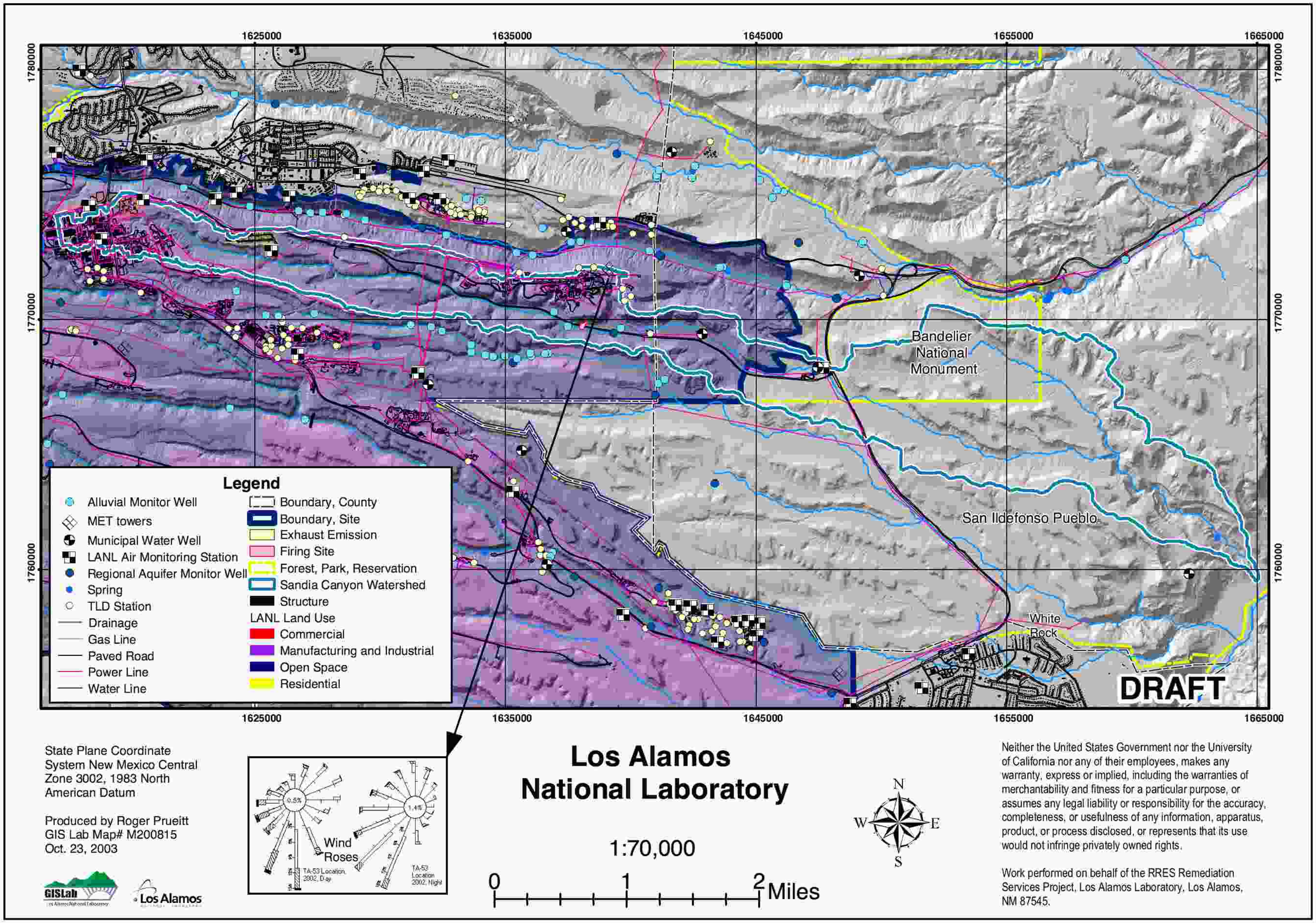

Figure 4.2b1. Hazard Area 2: Sandia Canyon Watershed, Hazard Category A: airborne releases, End state.

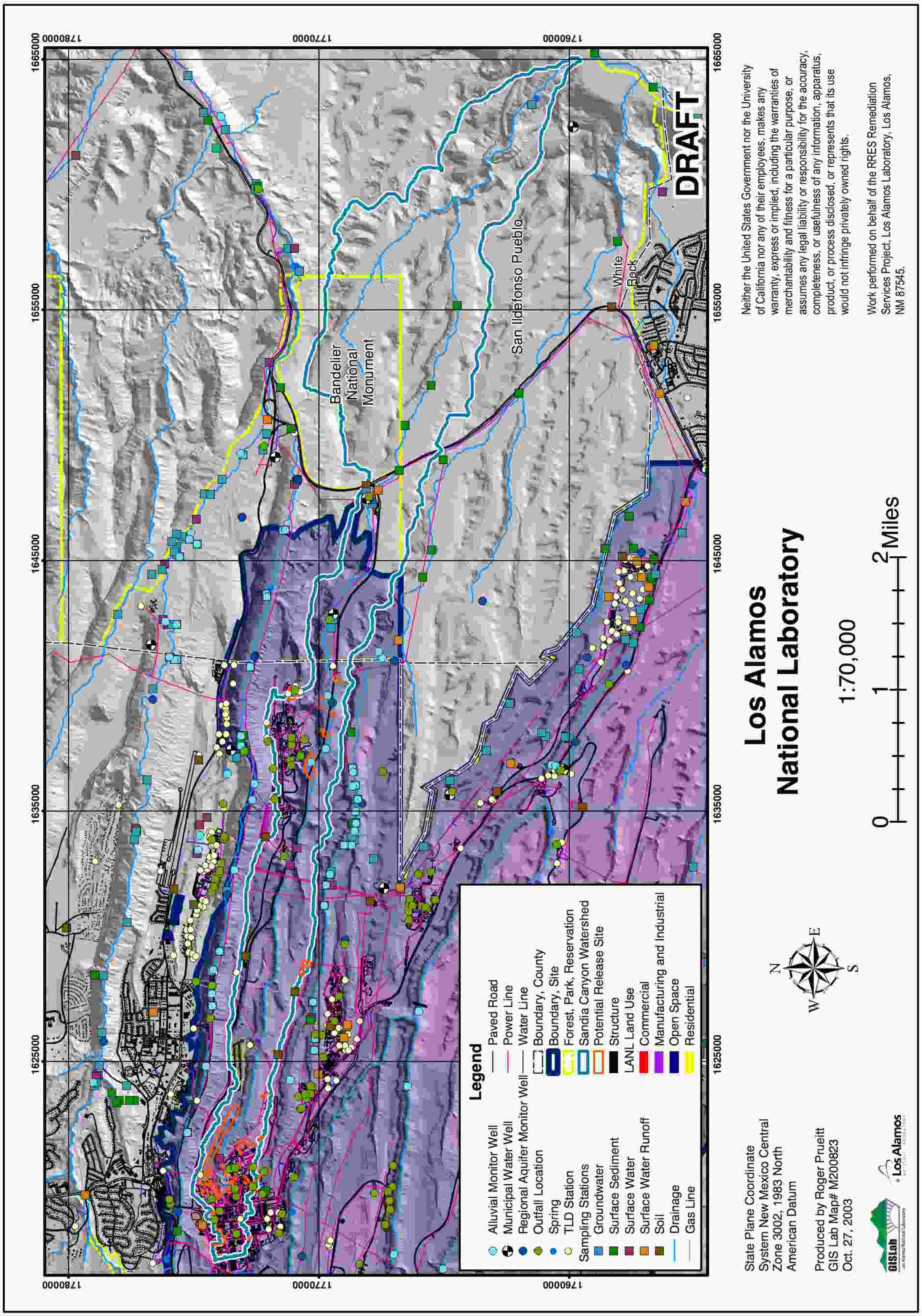

Figure 4.2b2. Hazard Area 2: Sandia Canyon Watershed, Hazard Category B: surface releases, End state.

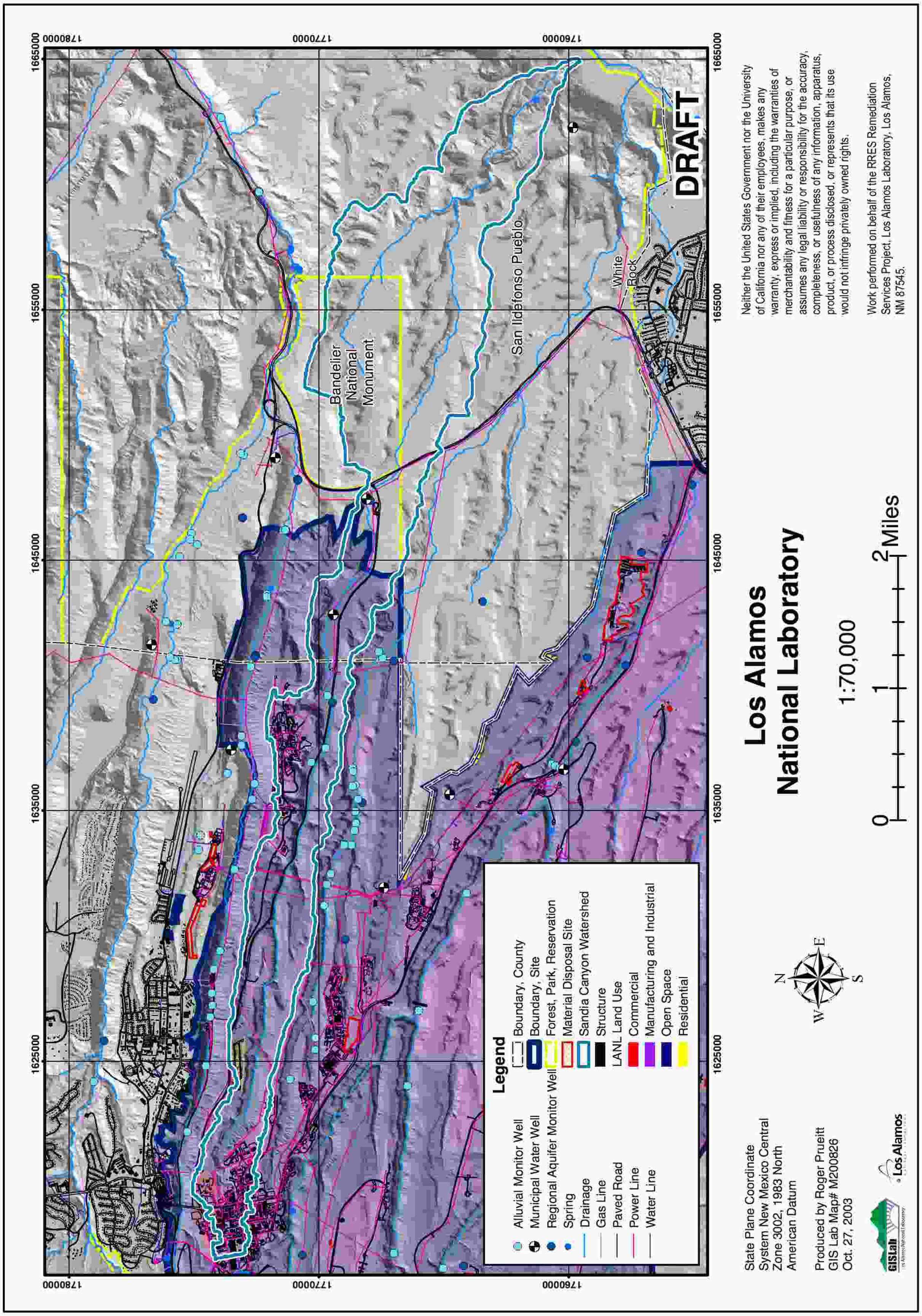

Figure 4.2b3. Hazard Area 2: Sandia Canyon Watershed, Hazard Category C: subsurface releases, End state.

filled the sediment traps with water. Samples of standing water in each of the traps were collected and filtered. The filtered water and the filters containing suspended sediments were analyzed separately (LANL 1997). The suspended sediment and water samples were analyzed for plutonium-238 and plutonium 239,240. The plutonium in suspended sediment was 10,000 to 100,000 times higher than in the water, but comparable to the plutonium content of sediments at other locations downstream of the liquid-waste outfall (LANL 1997).

Further studies on contaminant transport in the drainage indicate that plutonium and uranium in alluvial water and sediment decrease over a short distance from outfall sources. Nevertheless, data also indicate that there has been limited transport of plutonium in stream sediments across the LANL boundary.

4.3.1 Current State

Figure 4.3a1 shows the existing airborne sources of contamination in the Mortandad watershed. One is a firing site, and another is a building exhaust emission. The figure identifies the air monitoring stations and thermoluminescent radiation detectors (TLDs) that provide information needed to control exposures. The associated conceptual site exposure model identifies the pathway controls that are active for Hazard Category A under current conditions in the Mortandad watershed.

The existing sources of surface contamination within Mortandad canyon are shown in Figure 4.3a2, which includes a map and a conceptual site exposure model. The map shows existing surface sources are primary outfalls associated with ongoing operations, although there are several legacy sources. There are also a number of nuclear facilities within this watershed. Also indicated are the monitoring stations that provide information that ensures control of exposures. The conceptual model highlights the pathway controls that apply to surface releases.

Figure 4.3a3 identifies the subsurface contaminant sources in the Mortandad watershed, which are primarily MDAs.

MDA C

The MDA C was established in May 1948 and used for the disposal of radioactive and hazardous waste through 1965. The depth to groundwater below MDA C is approximately 1175 ft (353 m). The site is enclosed by a fence and posted. The average depth of the MDA C disposal pits was 20 ft (6 m), and the average depth of shafts was about 16 ft (4.8 m). The pits were filled between 1948 and 1959, and the shafts were filled between 1958 and 1965. The pits are capped with vegetated crushed tuff and the caps are also sealed. Based on limited written records, the total radiological inventory estimates of MDA C are 196 Ci in pits and 49,483 Ci in shafts (Rogers 1977, 0216). This estimate includes 28 Ci of uranium (uranium-233, -234, -235, -236, and -238); 49,136 Ci of cesium-137; 31 Ci of strontium-90; 26 Ci of plutonium-239; 149 Ci of americium-241; 50 Ci of mixed fission products; and 200 Ci of mixed activation products. These estimates were sufficient for the purposes of calculating cumulative impacts from potential radiological releases from MDA C and MDA G in the composite analysis that supports the technical authorization basis for MDA G. MDA C is located upgradient of MDA G, and is higher in the Bandelier Tuff. By analogy to MDA G, MDA C is expected to isolate contamination well beyond 2035.

MDA J

MDA J was used to dispose of administratively controlled waste from 1961 through 1998. Historically, MDA J received waste that was potentially contaminated with trace quantities of non-reactive HE residues. Other wastes included asbestos and residual amounts of hazardous waste. Land farming also occurs at this site to bioremediate petroleum-contaminated soils from other LANL sites. MDA J was closed as a special waste landfill in 1999. It is controlled by LANL.

MDA L

The MDA L site was used for disposing of hazardous materials and liquid wastes and the storage of gas cylinders. Early operations between about 1959 and 1985 included disposing chemical wastes within unlined pits and shafts dug into the mesa. Since the implementation of RCRA in 1986, MDA L

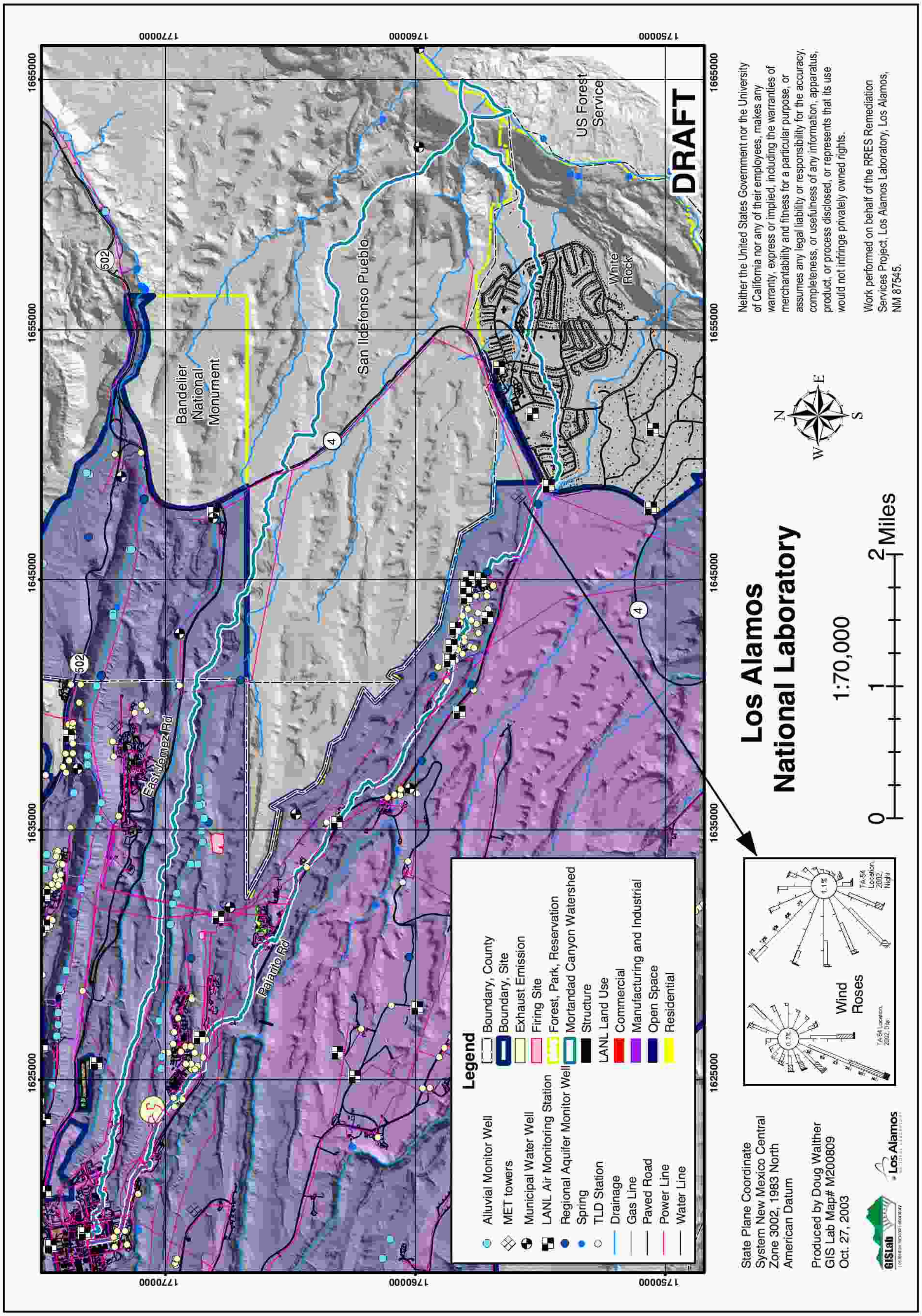

Figure 4.3a1. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category A: airborne releases, Current state.

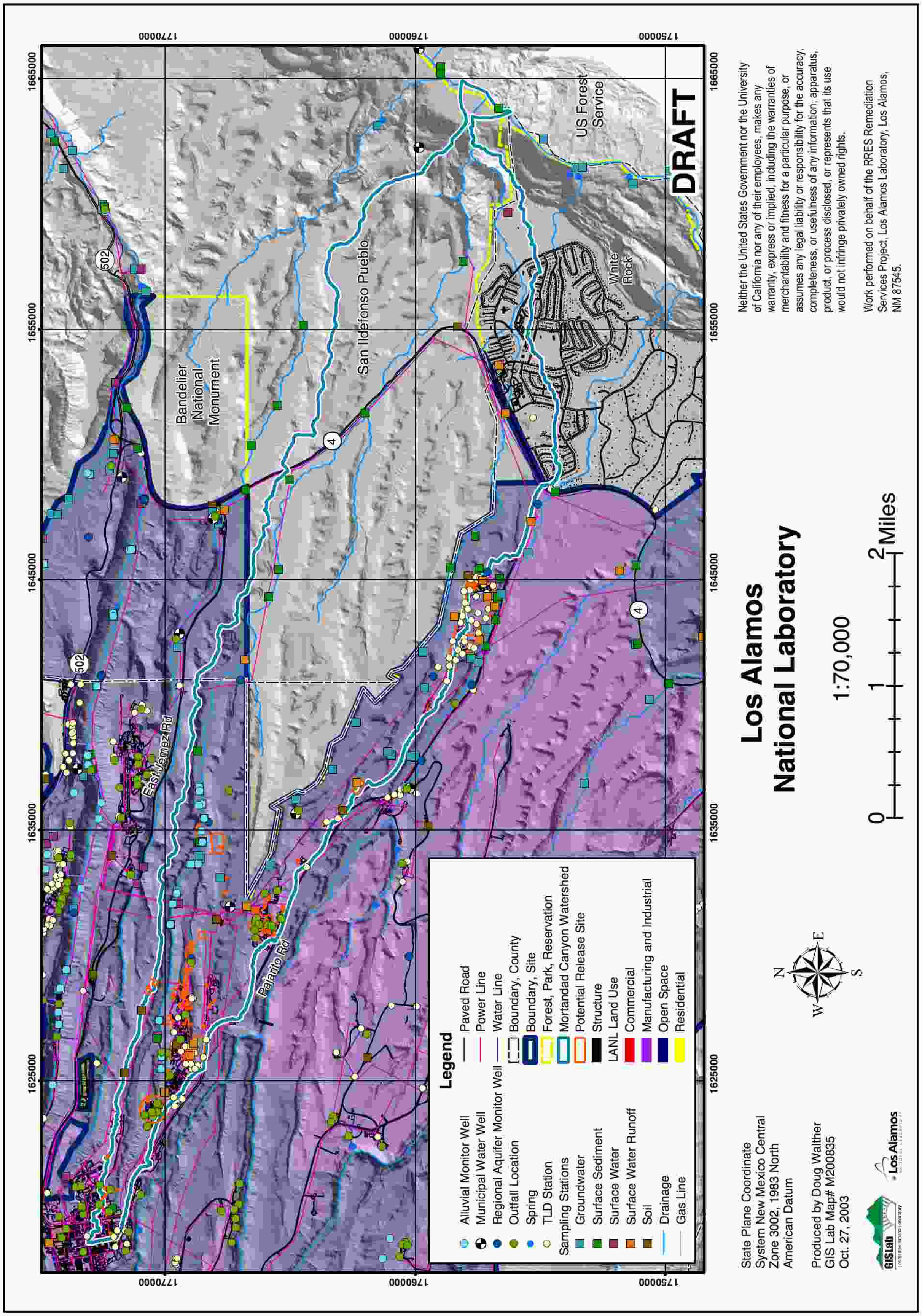

Figure 4.3a2. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category B: surface releases, Current state.

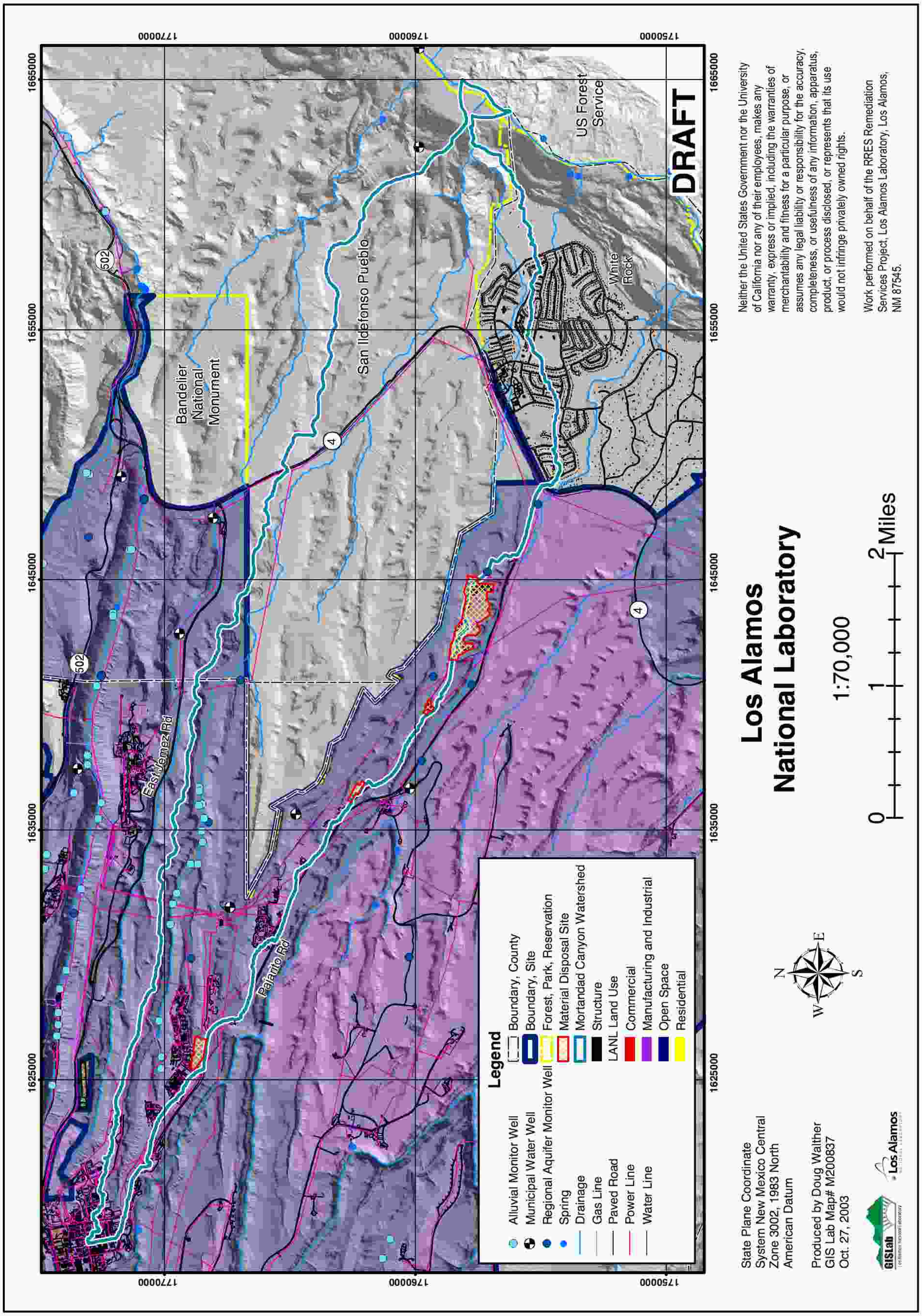

Figure 4.3a3. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category C: subsurface releases, Current state.

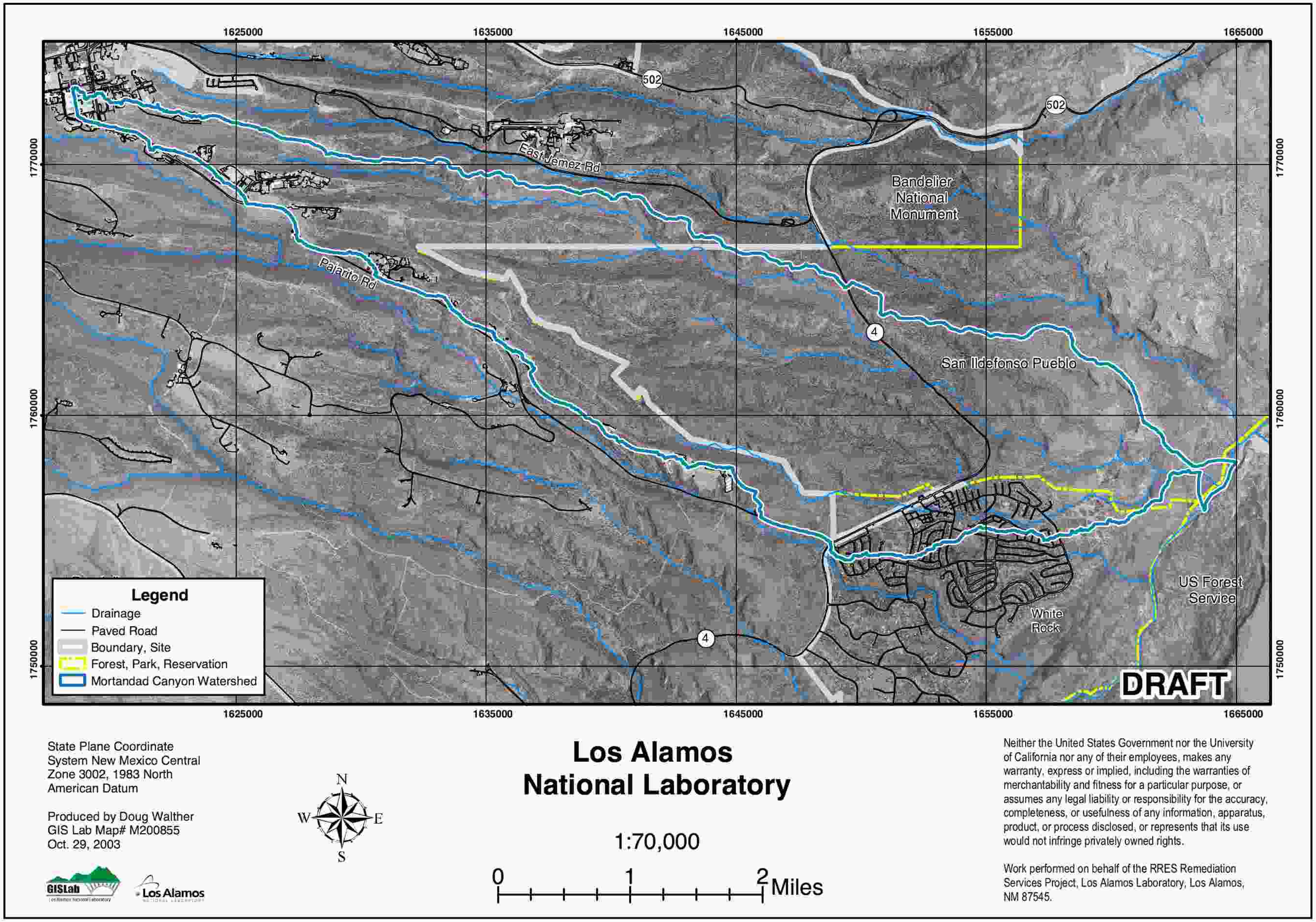

Figure 4.3a4. Hazard Area 3: Mortandad Canyon Watershed orthophoto map.

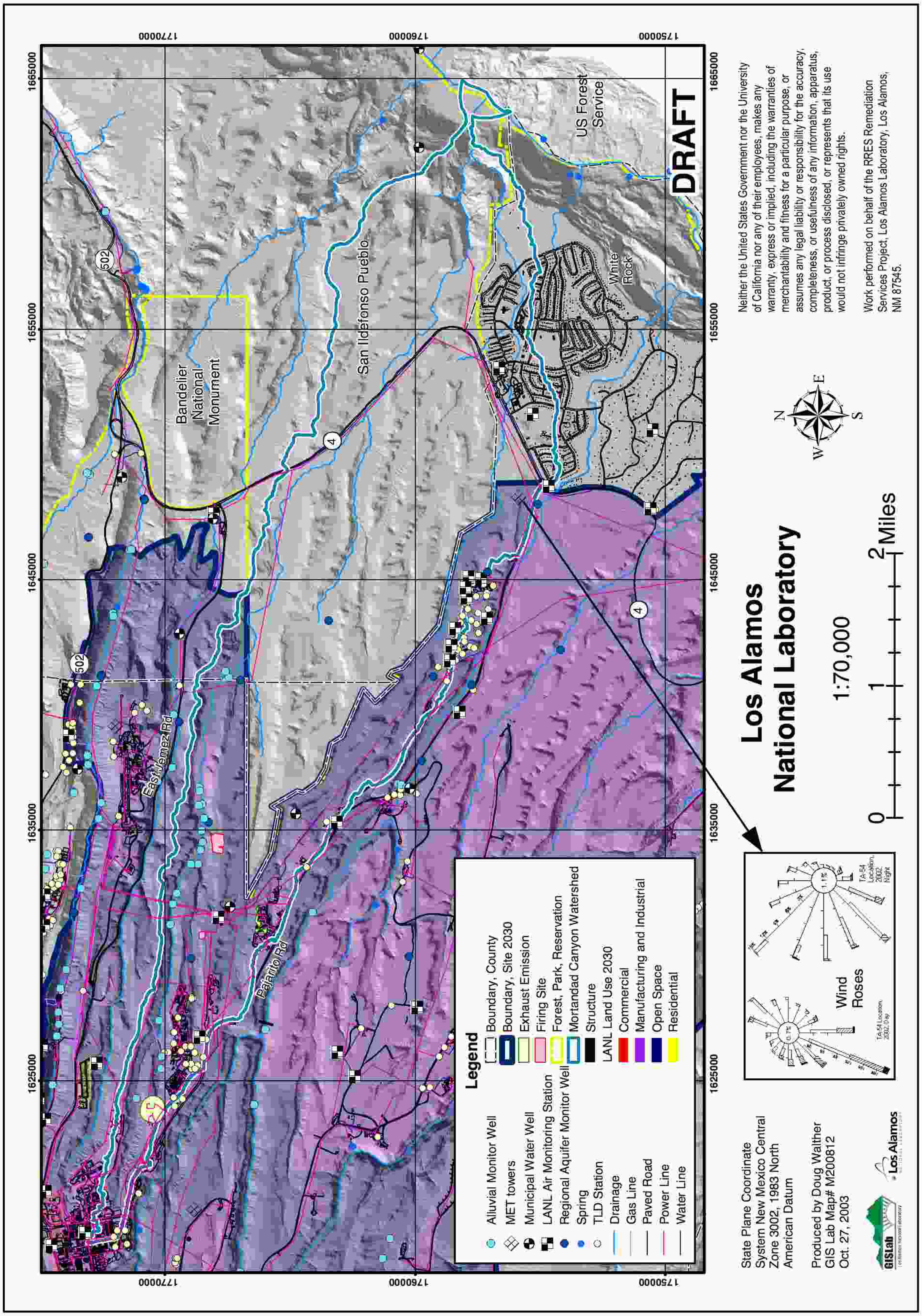

Figure 4.3b1. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category A: airborne releases, End state.

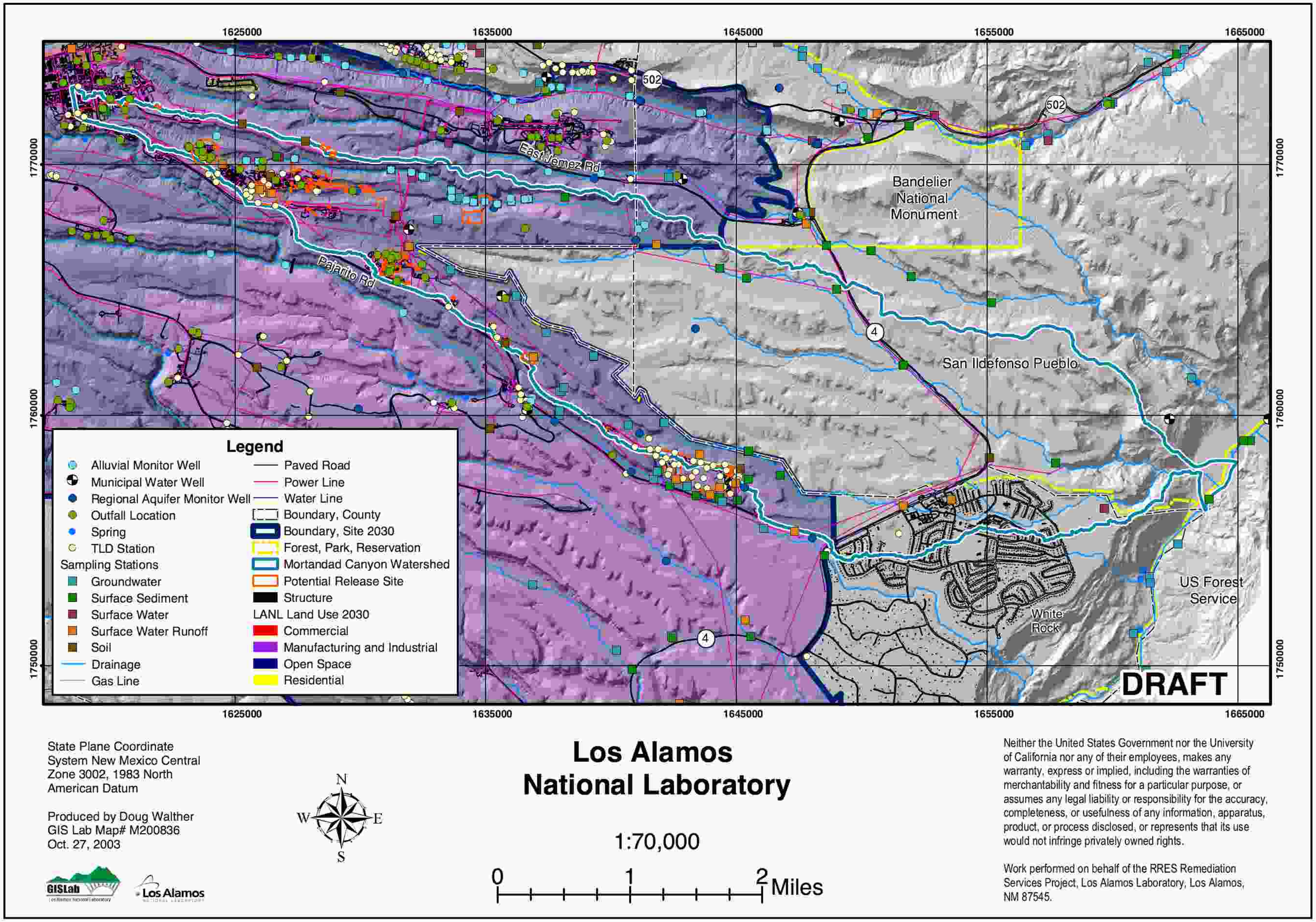

Figure 4.3b2. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category B: surface releases, End state.

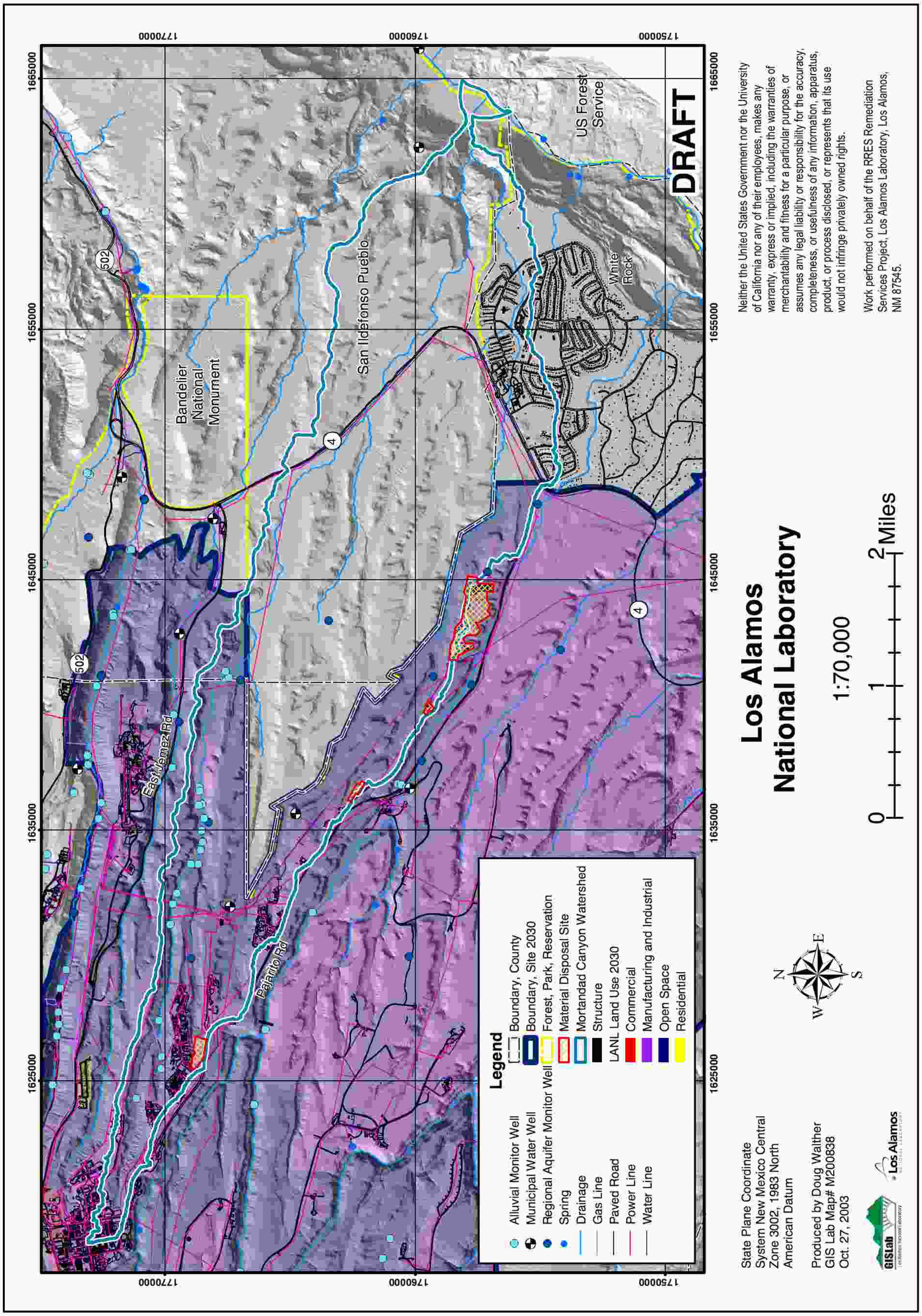

Figure 4.3b3. Hazard Area 3: Mortandad Canyon Watershed, Hazard Category C: subsurface releases, End state.

has been used in its present capacity for storage of RCRA waste, PCB waste, and some mixed waste (such as lead contaminated with radiation). In 1986, much of the previously used surface area was covered with asphalt to support surface structures. There is a well-characterized and analyzed vapor plume, containing primarily TCA and TCE. This plume is monitored to ensure worker safety, which provides a margin of safety for offsite exposures. In addition, three-dimensional simulation models have been developed to investigate the possible evolution of the plume under various scenarios, including the simultaneous rupture of multiple drums containing free product. The multiphase transport models demonstrate that the natural hydrological conditions and processes within the mesa can effectively attenuate both liquid and volatile chemicals such that concentrations in ambient air and groundwater will remain below regulatory standards and risk-based levels.

MDAs W and X

MDAs W and X contain waste from source preparation, radionuclide experimentation, and nuclear fission reactor development. MDA W is capped with concrete and sits on the southern edge of a mesa, with no potential for erosion of the cap. The depth to groundwater from the bottom of the carbon-steel-cased wells is around 1000 ft (300 m). MDA W was recommended for no further action after finding no evidence of a releases and robust engineering controls.

MDA X is the former site of the reactor from the Los Alamos Power Reactor Experiment No. 2 (LAPRE-II), which was buried in place after it was decommissioned in 1959. The depth to groundwater below the former location of MDA X is approximately 1160 ft (348 m). MDA X was remediated in 1991 as an interim action and recommended for no further action because all reactor-related equipment and contaminated soils were removed, and confirmatory sampling conducted on to ensure surface contamination was also removed.

The characteristics of the MDAs and the current state of monitoring and institutional controls that affect the exposures to hazards associated with MDAs in the Mortandad watershed are identified in the conceptual site exposure model attached to Figure 4.3a3.

4.3.2 Risk-Based End State

The risk-based end-state analogs of the current-state hazard-specific maps for the Mortandad watershed are shown in Figures 4.3b1, 4.3b2, and 4.3b3, for anticipated airborne, surface, and subsurface contaminant sources in 2035. Since surface contamination is the only significant hazard in this watershed, the end state reflects cleanup to industrial-use and/or recreational-use levels for lands that will be retained by LANL in 2035. The associated end-state conceptual site exposure model for Hazard Category B in Sandia watershed is attached to Figure 4.2b2. The natural processes that act to attenuate hazards associated with surface media discussed in Section 4.1.1 provide some control over both hazards and exposures, as indicated on the conceptual site exposure model.

4.4 Hazard Area 4 – Pajarito Watershed

The Pajarito watershed heads on the flanks of the Sierra de los Valles, on US Forest Service lands. It extends eastward for a length of approximately 15 mi across the south-central part of the Laboratory before entering Los Alamos County lands in White Rock. On this course it passes through numerous Laboratory technical areas. It covers a drainage area of approximately 8 mi^2.

On a regional scale, Pajarito Canyon is an interrupted stream attributable to several perennial springs in its upper reaches. These springs support flow in a perennial reach of the canyon, followed by an intermittent reach to within about 0.5 mi west of the Laboratory boundary. At about 1.0 mi east of the western Laboratory boundary, Homestead Spring supports another perennial reach for at least several hundred yards, followed by an intermittent and/or ephemeral reach that may extend down to near its confluence with Threemile Canyon.

East of this confluence, Pajarito Canyon is ephemeral across Laboratory land and Los Alamos County land through White Rock, down to a point about 0.4 mi upstream from its confluence with the Rio Grande. There a large perennial spring fed by the main aquifer, commonly called Pajarito Spring, supports perennial flow for the remainder of the distance to the Rio Grande.

In most years, snowmelt flows in the watershed for periods ranging from a few days to a few weeks. Snowmelt occasionally extends downstream as far as the confluence with the Rio Grande.

The primary LANL use of lands within the Pajarito watershed has been as the location of the Los Alamos Critical Experiments Facility and surface and subsurface MDAs, as a buffer zone for mesa-top firing site activities, and to a lesser degree for liquid waste disposal. These operations have been conducted in and have possibly discharged to Pajarito watershed and its tributaries since 1943. These early discharges were associated with outfalls, surface runoff, and dispersion from firing sites located. Additional discharges began with the continued expansion of LANL operations to new sites in the 1950s through the 1970s.

The Pajarito watershed encompasses land managed by LANL, land owned by the US Forest Service, Los Alamos County land, and privately owned land. Currently, hiking trails provide recreational access to the portion of the canyon within the LANL boundary and on Los Alamos County land. Local residents use a portion of the canyon east of the Laboratory boundary including White Rock Canyon for activities such as hiking, jogging, and rock climbing.

A significant portion of the residential community of White Rock is located within the Pajarito Canyon drainage downgradient of the LANL boundary. Residents have unrestricted access to the main drainage channel.

4.4.1 Current State

The current hazards, hazard control, and exposure controls currently present in the Pajarito watershed are shown in map-format and conceptual site exposure model format in Figure 4.4a1. The current airborne hazards include exhaust from facilities and open-air explosives detonations.

Figure 4.4a2 identifies the locations and associations of current surface releases in the Pajarito watershed, again in map and conceptual site model format. There are a number of liquid discharges from operating facilities, as well as potential release sites, including surface contamination collocated with MDA F subsurface hazards. The institutional exposure controls include monitoring of surface media, and access limitations. These controls, combined with natural attenuation by surface water and sediment transport discussed in Section 4.1.1 act to reduce the risks associated with exposures to surface contamination under current conditions.

Figure 4.4a3 identifies the locations of subsurface sources within the Pajarito watershed. It identifies three MDAs. The associated conceptual site exposure model identifies the institutional and natural controls that mitigate the potential for risk-significant exposures to these subsurface hazards. The characteristics of the MDAs contribute to an element of exposure control.

MDA F

MDA F consists of two fenced areas used in 1945 for surface detonation (“flashing”) of defective explosive lenses manufactured for use in the Fat Man implosion weapon. Some of these lenses contained Baratol, which contains barium and trinitrotoluene (TNT). In 1946, a pit was excavated to dispose of large classified objects that could not be easily cut. The objects were buried to protect their classification. In 1947, another pit was excavated to dispose other classified material. Two large disturbed areas, which may be these two pits, are visible on 1954 aerial photographs. From 1949 through 1951, work orders were written for three smaller pits to be used for occasional disposal. The locations and contents of these pits are unknown. From 1950 to 1952, three shafts were drilled to dispose spark gaps containing small amounts of cesium-137. The fenced have been continually monitored for radioactivity since 1981 as part of LANL’s environmental surveillance program. No readings above background have been observed. The depth to groundwater below MDA F is approximately 1275 ft (383 m).

MDA G

MDA G is a 100-acre (40-ha) site that has served as the Laboratory’s principal radioactive solid waste storage and disposal site since the Laboratory’s routine operations began there in 1959. The approximate average depth to groundwater is 1000 ft. MDA G will continue operating in its current capacity for the foreseeable future. Disposal units (pits and shafts) containing waste disposed before

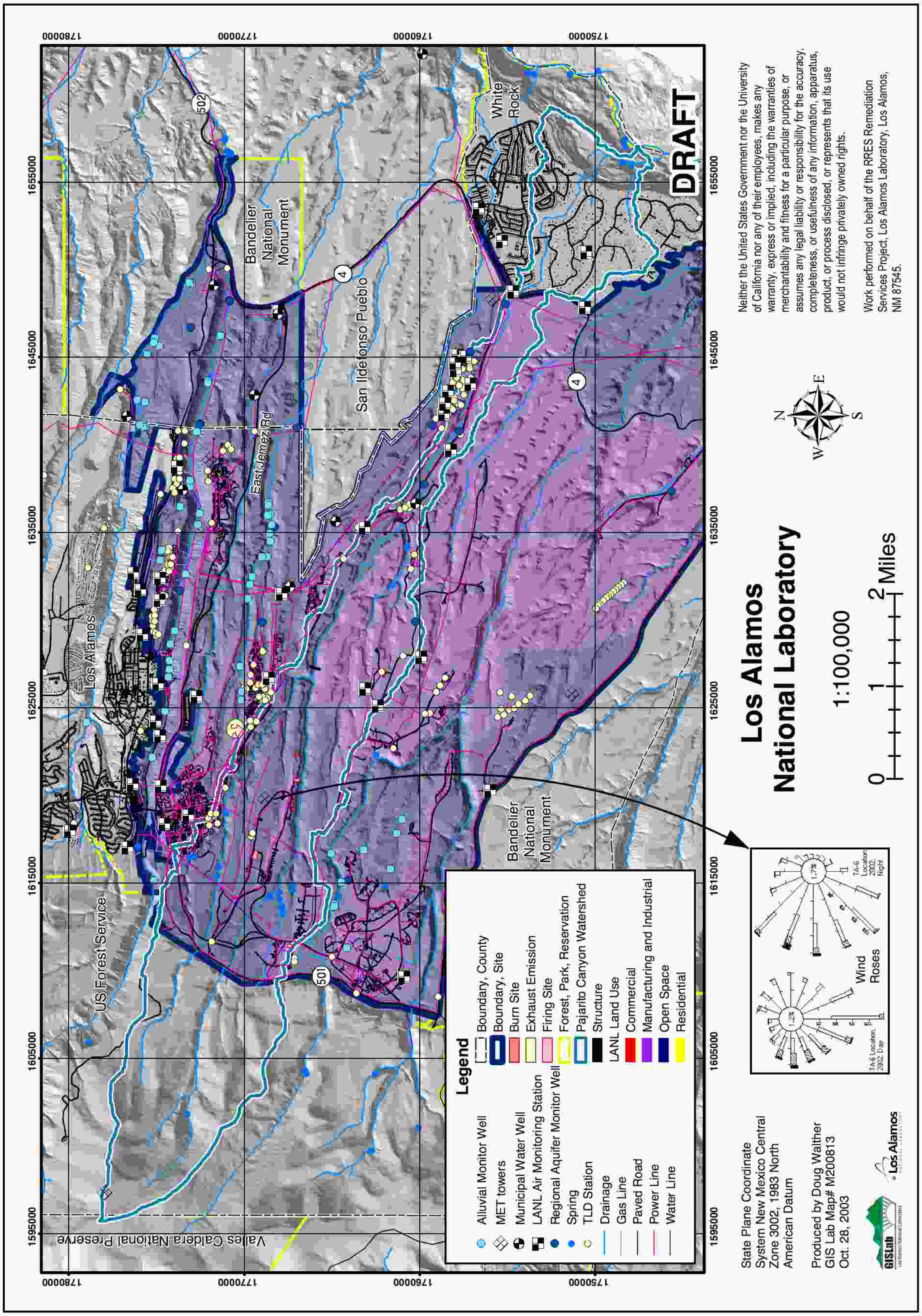

Figure 4.4a1. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category A: airborne releases, Current state.

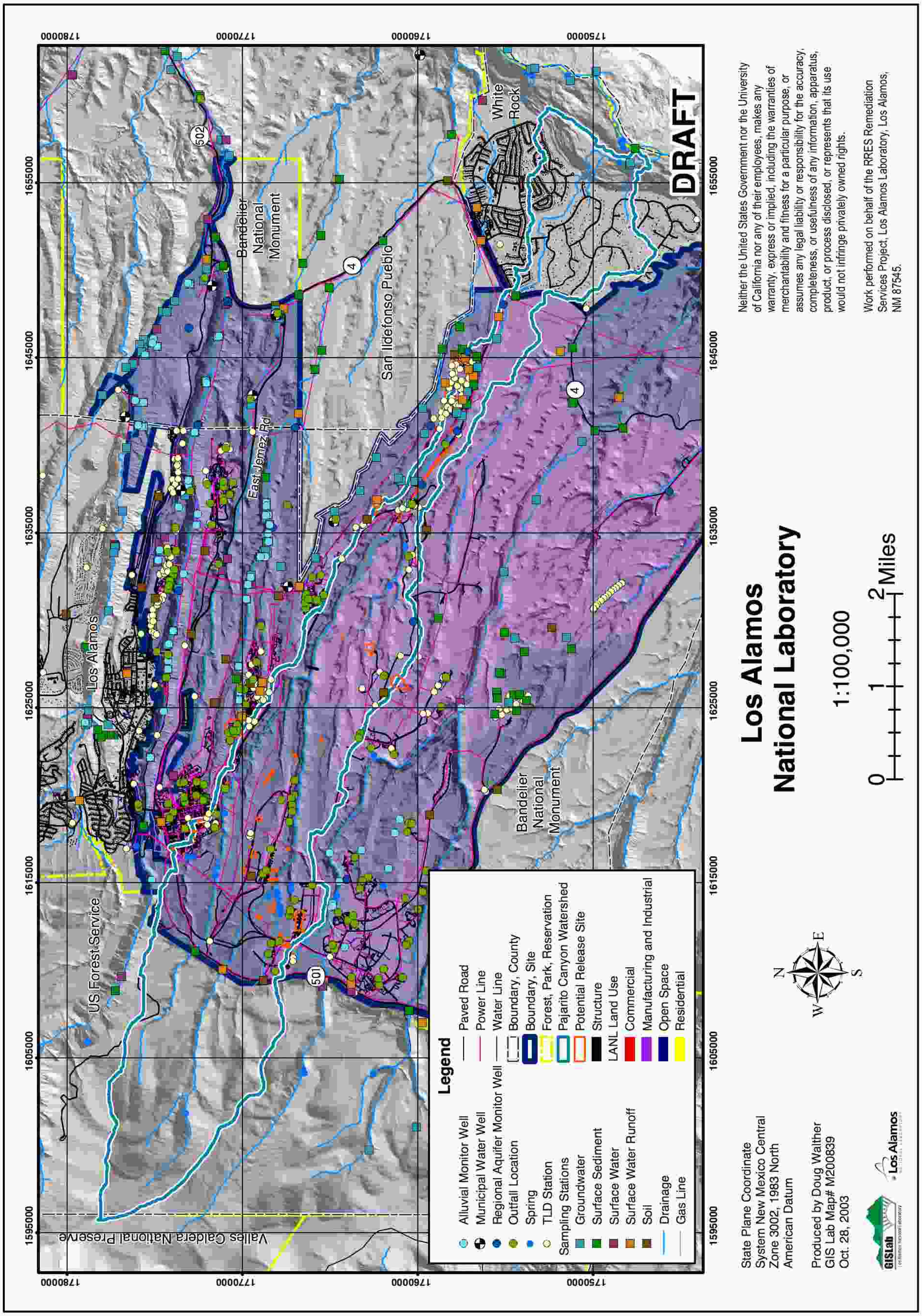

Figure 4.4a2. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category B: surface releases, Current state.

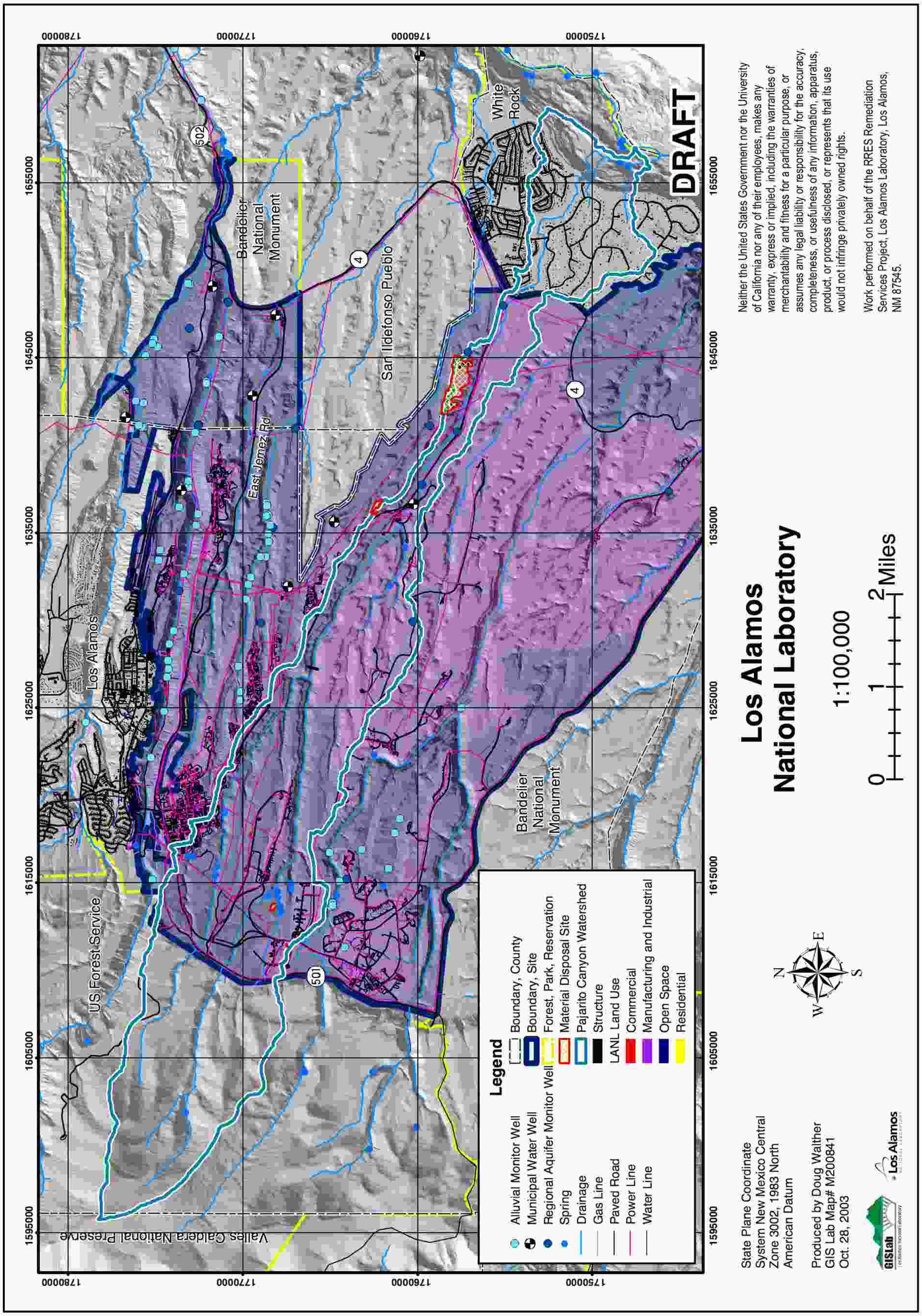

Figure 4.4a3. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category C: subsurface releases, Current state.

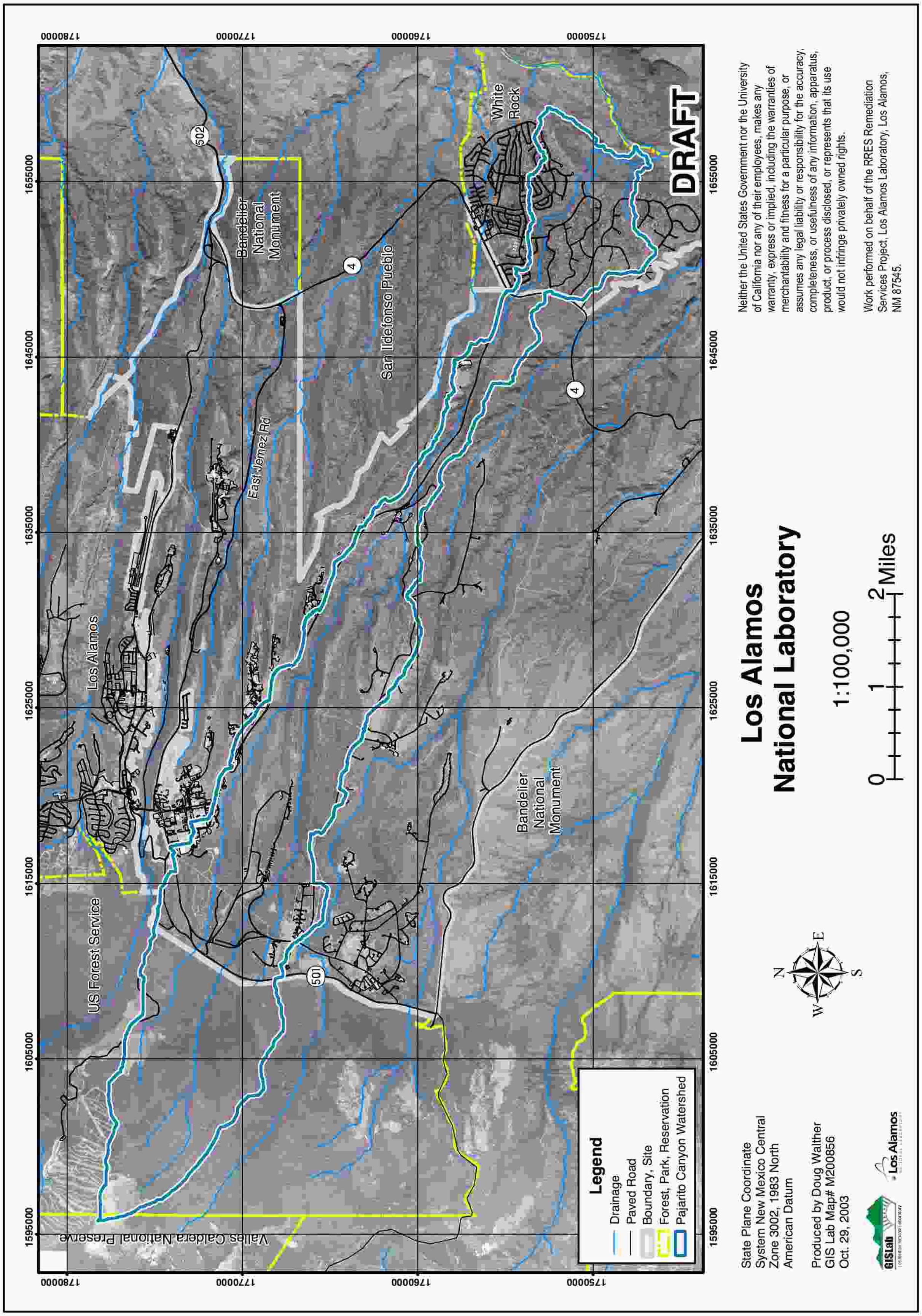

Figure 4.4a4. Hazard Area 4: Pajarito Canyon Watershed orthophoto map.

1988 are subject to cleanup. From 1959 to 1970 nearly all of the Laboratory's solid radioactive waste was disposed at MDA G. It was interred into pits and into lined and unlined shafts dug into the mesa. The depth of these pits and shafts is approximately 60 ft (18 m). Layers of waste in pits have been backfilled with clean excavated materials (crushed tuff), and filled pits have been covered with at least 1 m (3 ft) of crushed tuff and about 5 in. (12 cm) of topsoil, which has been re-vegetated with native grasses. Filled shafts have been capped with crushed tuff, concrete, or both.

In 1971, the Laboratory began segregating radioactive waste into two categories differentiated by the concentration of transuranic radioisotopes present in the waste. Since that time, transuranic waste has been retrievably stored at MDA G, and only low-level radioactive waste has been permanently disposed. Since the implementation of RCRA in 1986, low-level radioactive waste that also meets the definition of a RCRA listed or characteristic hazardous waste has been segregated and stored above ground at MDA G.

MDA G has undergone intensive scrutiny and as both a permitted RCRA storage facility, and an authorized DOE LLW disposal facility, and intensive investigation as a cleanup site. There are known to be subsurface vapor-phase plumes of volatile organic compounds (VOCs) and tritium, but no other releases have been found in the subsurface.

In 1997, the performance assessment and composite analysis of MDA G (Hollis et al. 1997, 63131) was published and approved to authorize continued disposals pursuant to DOE requirements. In addition, an RFI report for MDA G was submitted to NMED in 1999. The risk assessment performed for the MDA G RFI builds on the performance assessment and composite analysis, and it confirms the conclusions of the performance assessment, demonstrating that the administrative and natural controls currently in place are effective at containing contamination and attenuating potential releases such that no exceedance of regulatory or risk-based standards is anticipated.

MDA H

MDA H is a fenced 0.3-acre (0.12-ha) rectangular area measuring 200 ft by 70 ft (60 m by 21 m) on the same mesa as MDA G. The depth to groundwater from the surface at MDA H is approximately 1000 ft. Nine shafts were used for the disposal of classified wastes from 1960 to 1986. Records indicate that one shaft may contain a volume of 990 ft^3 (30 m^3) of hazardous waste. The shafts are 6 ft (1.8 m) in diameter and approximately 60 ft (18 m) in depth for a total disposal capacity of approximately 14,000 ft^3 (410 m^3). Waste disposal logs show that nearly every shaft received the following materials: weapons components, classified documents and paper, aluminum, plastic, stainless steel, rubber, graphite shapes, weapon mockups, depleted uranium scraps and classified shapes, film, prints and slides, classified shapes contaminated with high explosives (HE), and graphite reactor fuel rods. In addition, RCRA hazardous metals were disposed in many of the shafts. Eight of the nine shafts are capped by a 3-ft (1-m) layer of concrete and a 3-ft (1-m) layer of soil. One has a locked steel plate as a cover. A risk assessment confirms the long-term stability and performance of the site in its current state.

MDA Q

MDA Q is a 0.2-acre (0.01-ha) site where naval guns used during the development of Little Boy were buried in 1946. MDA Q occupies an irregularly shaped rectangular area with dimensions of approximately 270 ft by 260 ft (81 m by 78 m). The depth to groundwater below MDA Q is approximately 1200 ft (360 m).

4.4.2 Risk-Based End State

Attributes of the risk-based end state planned for the Pajarito watershed are shown in Figure 4.4b1, 4.4b2, and 4.4b3, for airborne, surface, and subsurface hazards, respectively. Each hazard category has an associated conceptual site exposure model. The conceptual site exposure model identifies the controls that are expected to be achieved consistent with the risk-based end state through 2035. It is anticipated that many of LANL's core-mission operations will continue to be conducted within the Pajarito watershed.

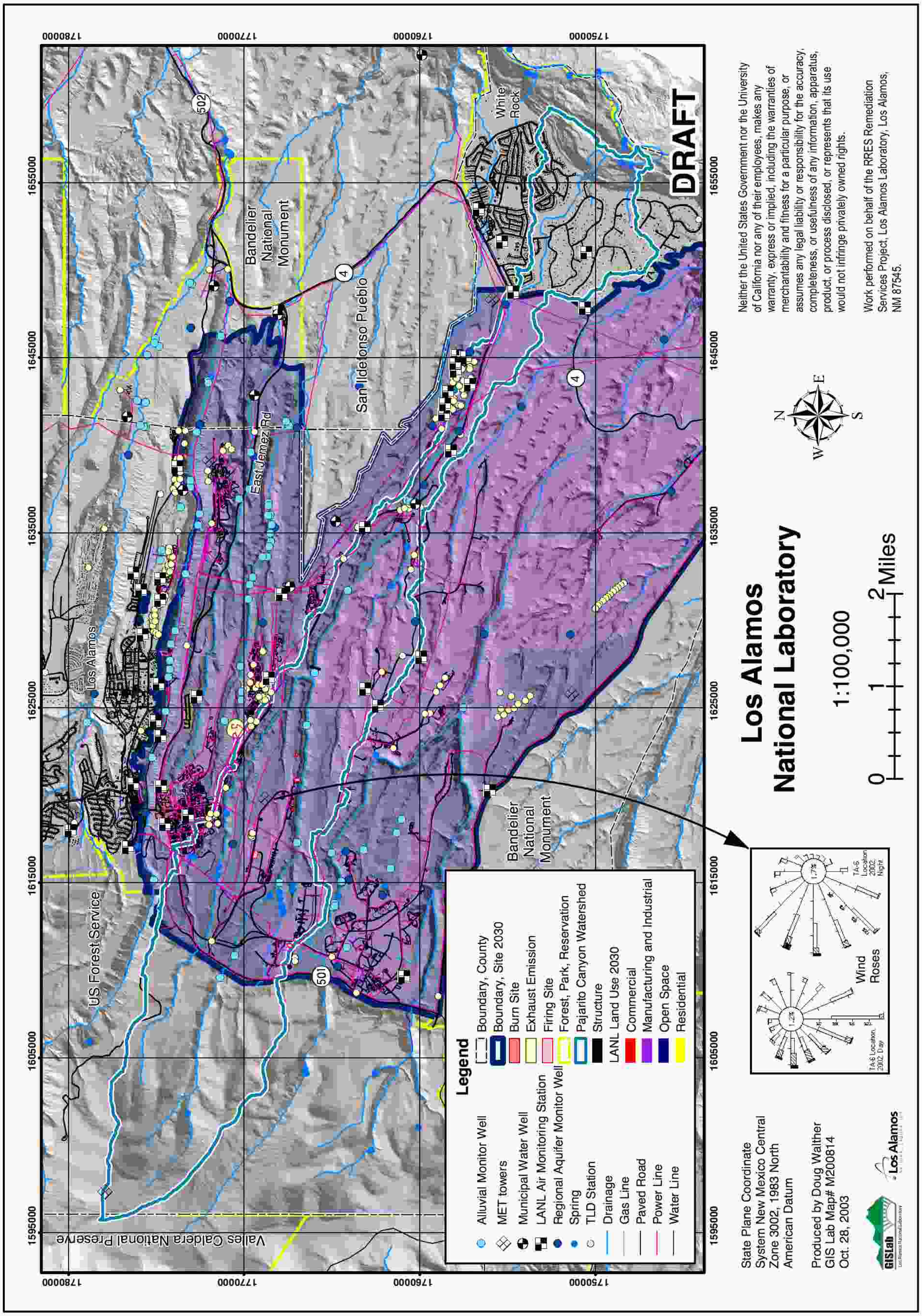

Figure 4.4b1. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category A: airborne releases, End state.

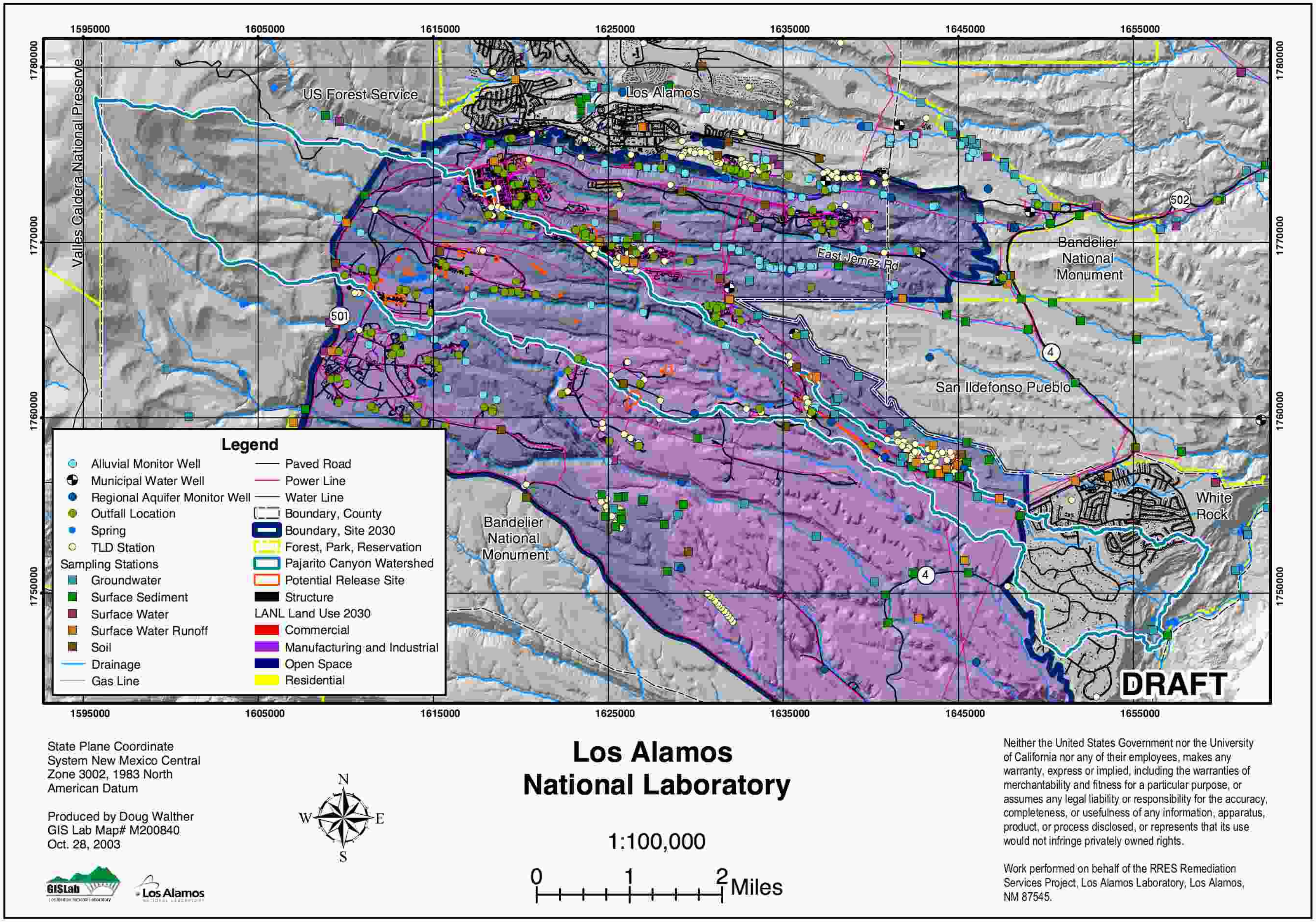

Figure 4.4b2. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category B: surface releases, End state.

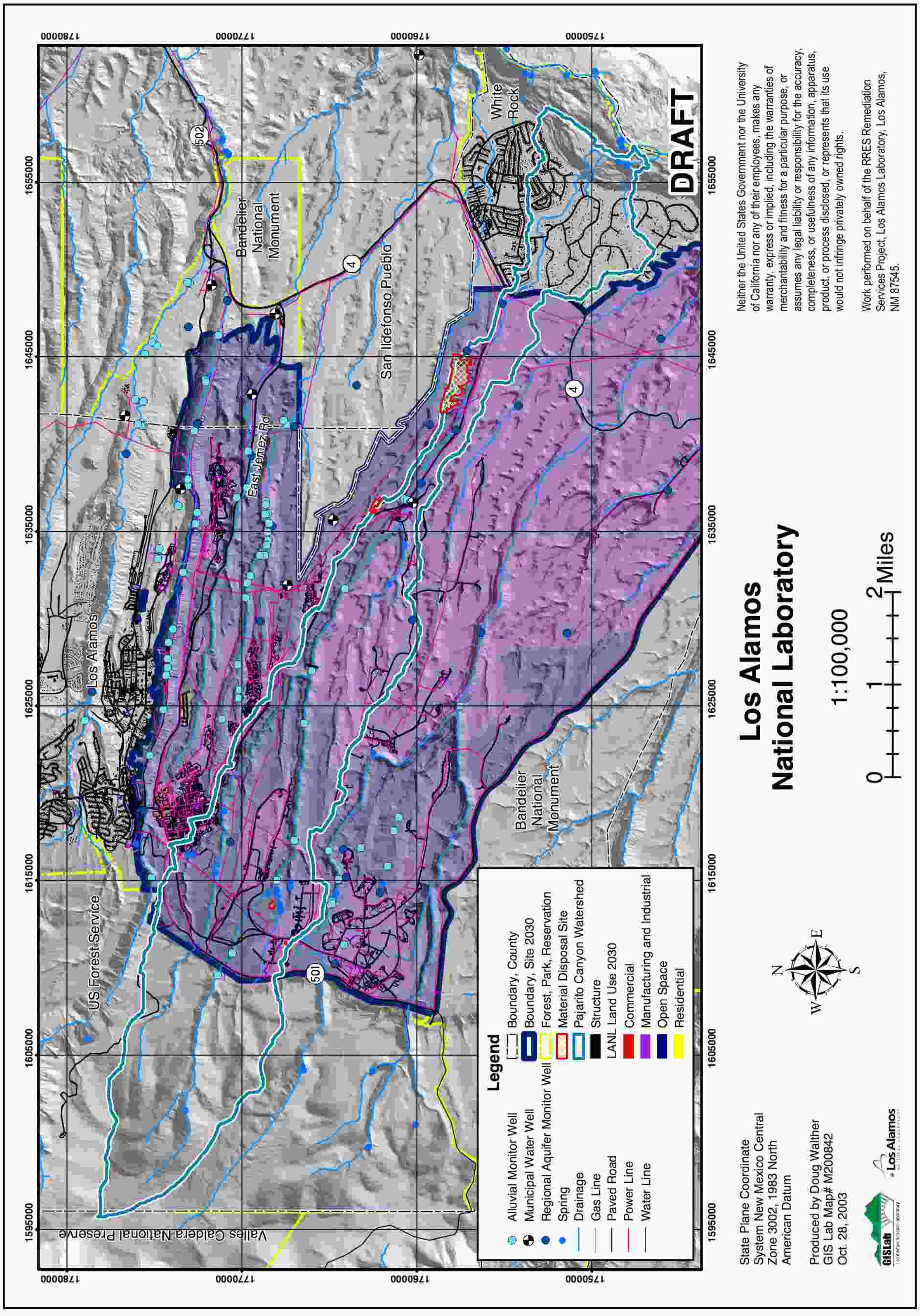

Figure 4.4b3. Hazard Area 4: Pajarito Canyon Watershed, Hazard Category C: subsurface releases, End state.